International Journal of Mechanical and Production
Engineering Research and Development (IJMPERD)
ISSN (P): 2249-6890; ISSN (E): 2249-8001
Vol. 8, Issue 3, Jun 2018, 31-38

CFD SIMULATION AND OPTIMIZATION OF POWER CONSUMPTION BY USING NANOFLUIDS

K. MAHENDRA KUMAR REDDY, P. BHARGAVA SAI,
D. SRIKANTH, M. DILEEP & T. TERESSA

Department of Mechanical Engineering, KL University, Guntur, India

ABSTRACT

In this paper, we deal with a CFD simulation and optimization of power consumption by using nanofluid. so in order simulation on heat exchanging process. During the turbulent flow of hot water and cold-water, the fluid flows in between to two chevron plates in plate heat exchanger. In that, we will design a three-dimensional plate heat exchanger. mean While we will give inlets and outlets boundary condition has been designed on a plate. The main reason for doing this simulation is to compare base fluid and nanofluid so that will check the overall heat transfer coefficient for a both fluids

KEYWORDS: CFD; Simulation; ANSYS CFD-Post; Heat Transfer; Plate Heat Exchanger; Heat Transfer Coefficient & Temperature Difference

Received: Mar 15, 2018; **Accepted:** Apr 06, 2018; **Published:** Apr 23, 2018; **Paper Id.:** IJMPERDJUN20184

Original Article

INTRODUCTION

In industries like heat power engineering is crucial using of heat exchanger because heat exchangers are used for transferring the more heat from one body to another body. so that using of heat exchanger we increase the productivity meanwhile industries are food, beverage, chemical, pharmaceutical, oil refining and other industries (1). In heat exchanger having many types of exchanger are they like shall and tube, double pipe, plate heat exchangers etc. in this plate type heat exchanger having high efficiency compared to the other heat exchanger because the plate heat exchanger having a large surface it useful to transfer the more heat and high thermal conductivity and no need to clean like shall and tube heat exchanger. in this plate heat exchanger, the water flow is turbulent so that the heat transfer coefficient is high and the flow rate is low. If we increase the plates in plate heat exchanger we transfer the more heat and also plate type heat exchanger having corrugation angle it is us for indication of the flow of water. In this pressure drop and heat transfer coefficient is proportional to mass flow rate and inversely proportional to chevron angle. (2)

Using of nanofluid it is very useful for cooling the system fastly and thermal conductivity is also high while comparing to the other coolant. in this will using the al203 nanoparticles because al203 nanoparticles having high thermal conductivity and heat transfer coefficient high compared to the other nanoparticles and cost also less compared to the other nanoparticles (3)

While doing the calculation on plate heat exchanger we will find the area of plate, general warmth exchange coefficient, mass stream rate. in this while doing calculation we can include the no. of plates we using in

plate heat exchanger (4). After doing calculation will compare with CFD simulation on plate heat exchanger.

While using the CFD software we have many advantages are there, the main advantage is we can see a visualization of simulation. Before we doing experiment, we do in CFD software because if any error came while doing experiment will getting money and time loss so first, we do CFD simulation in that simulation we will get any problems then we will rectify the problem on CFD then after will go to experimental and also time take for simulation very less comparing to the doing of experimental. another advantage is we will have the option of doing simulation in 3D dimensional design so that we will see the working of simulation is very clearly. (2)

Specification of Plate Heat Exchanger

Table 1

Material	Length L (m)	Width W (m)	Spacing (mm)	No. of Plates
steel	0.0762	0.0236	2	3

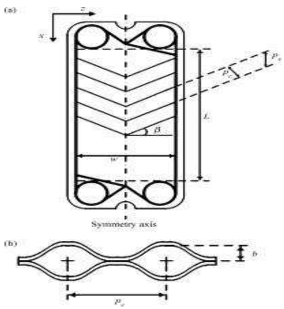


Figure 1

THEORETICAL METHODOLOGY

Base Fluids

Then calculate LMTD to some mean temperature difference by means of the relation: -

$$LMTD = \frac{(\Delta Tc - \Delta Th)}{ln\left(\frac{\Delta Tc}{\Delta Th}\right)}$$

$$\Delta Ti = Thi - T_{co}$$

$$\Delta Tc = Tho - Tci$$

With the assumed Uo, a value of the heat total heat transfer area of plate required can be calculated as A_T is given by relation.

$Q = U_O A_T \Delta T_{LM}$

Choose the Effective area of the plate, which includes plate length, width, and thickness of the plate.

Total material required in kg mass (m)=ρAV

Nanofluids

The density of nanofluid is

$$\rho_{nf} = (1 - \emptyset)\rho bf + \emptyset\rho np$$

Specific heat of nanofluid is

$$Cp_{nf} = \frac{(1-\emptyset)(\rho Cp)bf + \emptyset(\rho Cp)np}{\rho nf}$$

Amount of nanoparticles that are to be mixed into the base fluid is

$$V\% = \frac{\frac{Mnp}{\rho np}}{\frac{Mbf}{\rho bf}+\frac{Mnp}{\rho np}} *100$$

WORKING METHODOLOGY

3D model is produced utilizing pro-E out of control fire CAD software in the present proposal, the get together is considered for examination. In reference writing, just proposal, the get together is considered for investigation. At first, 4 plates gathering used to acknowledge settings for conjugate interface coupling and limit conditions. Later in CFD solver work is copied to coordinate a required number of plates. The display is appeared as in figure 3.(5)

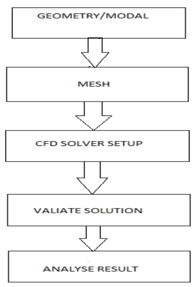


Figure 2

Mesh Generation

Work will create utilizing ANSYS ICEM CFD instrument. Lattice approach included hexa coinciding which brings about organized cross-section. Tetra work approach attempted yet the issue in dealing with a substantial number of components. Equipment unfit to process such huge model. Thus, the methodology was moved to hexa work. it makes a limited number of components. The work close-by to dividers was fine-coincided be both catches warm, speed limit layer impacts. (5)

Solver

Ansys CFD device is utilized as a solver. CFD solver has numerous abilities like work can be copied for some examples and associated with interface coupling. Additionally, to recreate conjugate strong liquid space we present unique border treatment alternative in the primary circumstance, 4 plates have coincided in ICEMCFD. A similar work stands rehashed and coupled utilizing interface association with a guarantee the adequacy of various plates. There included of choices to guarantee

Reasonable limit conditions.

Solver Setting Involve

Characterizing spaces as liquid and strong areas, making combine coupling of these areas. Characterizing material assets for every area. To catch turbulence K-e demonstrate is chosen. Solver QUICK plan is measured. A power law with zero degrees conditions is considered. Delta in addition to limit situations is usual in light of the emphasis

Table 2

Discretization scheme	quick
Weight-speed coupling	simple
Turbulence model	k-E
Boundary layer catch plot	Control law
Convergence zone criteria	E-4
Convergence iteration	1000
Viscous effect	on

Conjugate warmth exchange and stream limit condition:

In this limit, shape thought about affirmed after few cycles

Table 3

Parameter	Inlet Temperature	Outlet Temperature	CFD Outlet Temperature	Mass Flow Rate	Error%
Cold fluid	311	333	342	2.627	0.04
Hot fluid	361	338	343	2.627	0.1

- Hot and cold liquid gulf the mass stream rate of the liquid
- Hot and cold liquid outlet: average static weight
- Warm initialization for conjugate heat transfer
- Strong liquid association for conjugate warmth exchange

Multiphase Modelling

In the present examination, blend demonstrate approach was utilized where the distinctive stage is dealt with numerically as interpenetrating continua and the idea of stage volume the blend show is generally straightforward and exactly for multi-stage stream the examination contrasted with Eulerian and VOF.

The blend display is a streamlined multiphase model that can be utilized for streams where the stage at various speed. The blend show is additionally competent to display any number of stages, solving the momentum, continuity and energy equation for the mixture, the volume fraction equations Table1: variable properties

For the secondary phases, and algebraic expressions for the relative speed. (6)So that we will take al2o3 volume particles in the primary phase and water will be taken in the secondary phase, then after we give the properties of primary phase and secondary phase and initialize The properties and start the process and give iteration for the show the variation in a plate

Analysis and Approval of Approach

For the main case,4 plates are considered to approve the outcomes with pragmatic and diagnostic computation. With a reference we see the special result developed in excel sheet and also find the effective area for make to guarantee

wanted warmth exchange. Exceed expectations sheet is based on empirical relation. This theory accentuates approval of CFD ,come about with scientific and pragmatic outcome. The following are the parameter shown in below

Table 4: Comparison of Base Fluid and Nanofluid Outlet Temperature While Done in CFD Simulation

Parameter	Cold Fluid Properties	Hot Fluid Properties	Nano Fluid Properties
Content	Water	Water	Nano particles
Density	1000	1000	3600
Viscosity	1.87E-0.4	1.87E-0.4	
Specific heat	4210	4210	4.0611
Thermal conductivity	0.5	0.5	40

RESULTS AND DISCUSSIONS

THE ANALYSIS is completed according to various stages talked about beneath in that, we demonstrate temperature appropriation in plate heat exchanger while utilizing nanofluid and base water

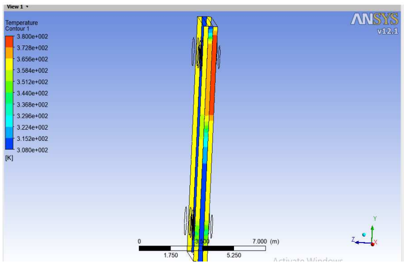


Figure1: Temperature Variation in Plates While Using Base Fluid

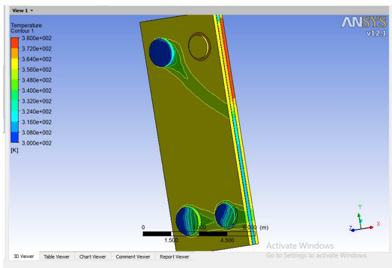
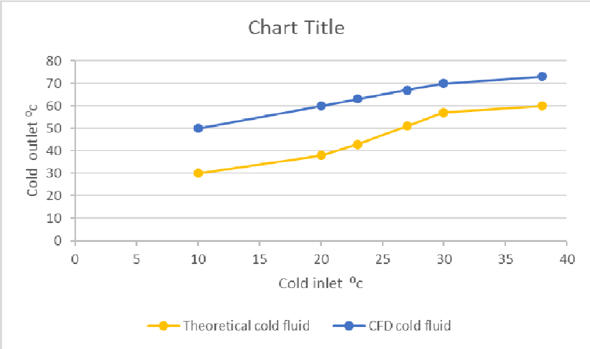


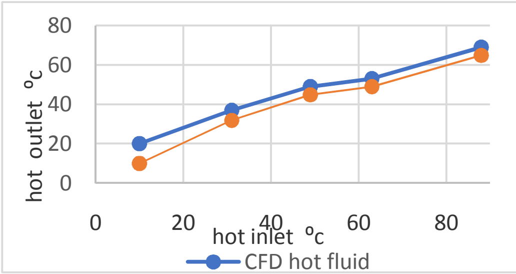
Figure 2: Temperature Distribution on the Plate

Table 5: Comparison of Theoretical and CFD Outlet Temperature

Parameter	Inlet Temperature	Cfd Base Fluid Outlet Temperature	Cfd Nano Fluid Outlet Temperature	Temperature Difference
Hot fluid	361	343	332	10
Cold fluid	311	342	322	21

In that, we will plot the line by utilizing a temperature's of hypothetically and CFD esteem for the chart. And also, we represent the over heat transfer coefficient by using graph.





Chart

In the diagram, we watch that the temperature of the two outlets is slightly expanding while thought about of both hypothetical and CFD. So that we will want to utilize the CFD software for doing the trial since will decrease the ideal opportunity for doing the analysis

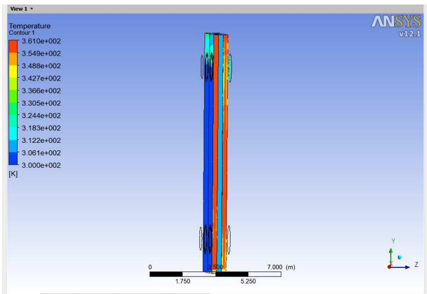


Figure 3: Temperature Distributing on the Plate

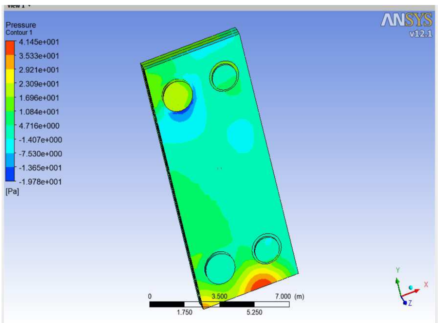
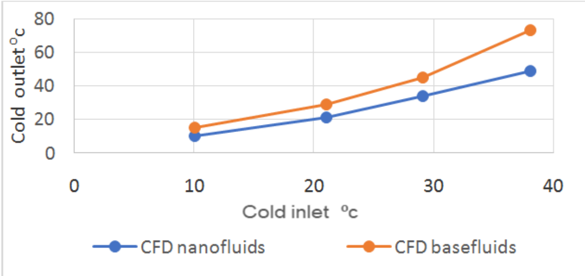
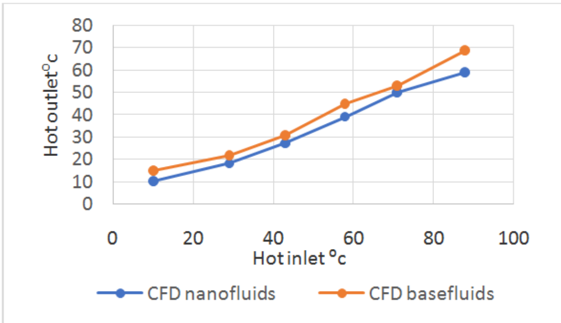
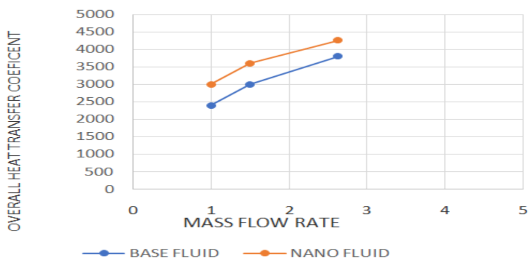


Figure 4: Temperature Change in Plates While Using Nanofluid

Here we realize that temperature distinction amongst nanofluid and base liquid as for being ascertained as now while taking those understandings we will plot the outline







In the wake of seeing this diagram will distinguish that nanofluid is utilized to exchange more heat contrasting with the base liquid in the middle of the plate so we final that to incline toward the nanofluid for diminishing the heat in the heat exchanger. In that, we will see the overall heat transfer in plate heat exchanger is high compared to the base fluid as shown in the below.

CONCLUSIONS

- In the present paper, we have taken the experimental temperature of both inlet and outlet water.
- Also, we did the simulation in the CFD on Plate heat exchanger and obtain the temperatures of inlet and outlet water (base fluid).
- The same simulation is done with Al2O3 nanofluid instead of water and obtains the results for temperatures for same mass flow rates.
- The comparison is done for the temperatures of the inlet and outlet water for the above three process that means the experimental values with base fluid, CFD simulation with base fluid and with CFD simulation with Al2O3 nanofluids.
- The results observed that there is less difference between experimental and CFD simulation, hence simulation is preferred than experimental values.

REFERENCES

1. *Dnyaneshwar B. Sapkal[1], smair j.deshmukh[2], Rucha R.kolhekar Computer Aided Design CFD Analysis of Plate Heat Exchanger 2015*
2. *Jan skocilasa[1],levgen palazikb[2],CFD simulation of the heat transfer process in a chevron plate heat exchanger using the sst turbine model 2015.*
3. *[1]Arun Kumar Tiwari enhancement of heat transfer by using nano fluid in a heat exchanger 2015*
4. *[1]Sreejith K., [2]Basil Varghese, [3]Deepak Das, [4]Delvin Devassy, [5]Harikrishnan K.,[6]Sharath G. K., Design and Cost Optimization of Plate Heat Exchanger 2014.*
5. *Mandapudi, Snigdha, Satya Sandeep Chaganti, And Swathi Gorle. "Cfd Simulation Of Flow Past Wing Body Junction: A 3-D Approach."*
6. *Vinay Patil[1], Manjunath H[2] and Basavaraj Kusammanavar[3] validation of plate heat exchanger design using cfd 2013.*
7. *Athulya A.S[1], Miji Cherian R[2] CFD modelling of multiphase flow through t junction 2015.*